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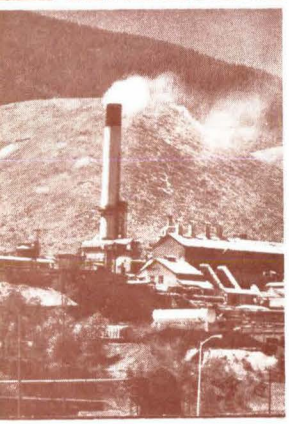

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HARVESTING STRATEGIES FOR MANAGEMENT OF MOUNTAIN PINE BEETLE INFESTATIONS IN LODGEPOLE PINE, MONTANA
Establishment Report

by

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INTRODUCTION

This report documents establishment of a series of plots to evaluate harvesting strategies for management of mountain pine beetle, *Dendroctonus ponderosae* Hopk., infestations in lodgepole pine stands. Management practices are to be based on correlations between phloem thickness and tree diameter to incidence of mountain pine beetle attack and subsequent brood survival.

Epidemics of mountain pine beetle have occurred frequently with extensive losses in the Northern Region. (Ciesla, 1971; McGregor and Tunnock, 1971; McGregor and Dewey, 1971; McGregor, 1973; McGregor et al., 1975). Generally these epidemics have been directly related to stand structure. Food is one, if not the leading, regulatory factor on the survival of mountain pine beetle broods (Amman, 1969). Phloem of the host tree serves as food for larvae, and number of larvae surviving to adults within a given area depends in part on phloem depth (Amman, 1969). Stand density and plot elevation are the next strongest independent variables (Amman, 1973; Amman, et al., 1973) although they contribute

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relatively little to the overall multiple correlation. Phloem-tree diameter relationships can be variable; however, large diameter trees generally contain thick phloem and small diameter trees thin phloem.

During the course of mountain pine beetle infestations, large diameter trees are usually infested and killed first each year, as well as over the life of an infestation (Cole and Amman, 1969). Large trees usually produce more beetles per unit area of bark and more per tree due to their greater surface area. For example, on the Teton National Forest, only infested trees 13 inches d.b.h. and greater produced more beetles than they absorbed (Cole and Amman, 1969).

The problem, then, is to manage lodgepole pine stands in such a way as to reduce and/or prevent potential buildup of mountain pine beetle. Cole and Cahill (In press) developed probabilities of loss based on phloem-diameter distribution, and demonstrated, in theory, that harvesting strategies can be implemented to eliminate or at least greatly reduce mountain pine beetle epidemic potential.

The current series of studies in Montana is part of an inter-Regional study intended to develop more fully these proposed harvesting strategies. Studies over a 3-year period will be conducted in mountain pine beetle infested lodgepole pine stands on the Gallatin National Forest, Montana, Medicine Bow National Forest, Colorado and in Idaho, (R-4). Presented here are the methods and results of the 1974 preharvest sampling survey in Montana.

METHODS

Six 40-acre blocks of lodgepole pine were selected on the Gallatin National Forest in Montana. Blocks were selected in stands containing current mountain pine beetle infestations. Each block will receive one of the following harvesting plans prior to beetle flight in 1975:

1. Remove all infested and green trees above 12 inches d.b.h. regardless of phloem thickness.

2. Remove all infested and green trees above 10 inches d.b.h. regardless of phloem thickness.

3. Remove all infested and green trees above 7 inches d.b.h. regardless of phloem thickness.

4. Remove all infested and green trees with 0.10 inch phloem thickness (based on an average of two chip samples taken at breast height from each tree); minimum diameter to be 8 inches d.b.h.

5. Remove no trees on two control blocks.

Success of the study is dependent on completing these harvesting plans prior to emergence of adult beetles in 1975.

Preharvest sampling was conducted during October and November 1974. Tree marking for harvest was conducted simultaneously with plot sampling. Trees were inventoried on a systematic grid pattern. This type of sampling has given results with less than 10 percent error (Cole and Amman, 1969). Within each of the seven stands, twenty 1/10-acre plots were equally spaced in each 40-acre area. A hypsometer was used to determine if trees fell within plot boundaries. To obtain an estimate of phloem thickness for each tree diameter class, representative bark samples were removed from opposite sides of two green, uninfested trees in each d.b.h. size class. Phloem thickness was measured to the nearest one-hundredth of an inch using a steel ruler. Tree diameters were measured to the nearest one-tenth inch.

In addition to the twenty 1/10-acre plots, forty 1/4-acre plots were taken to determine level of beetle infestation except for the phloem-cut block where a 100 percent cruise was used. A hypsometer was used to determine if trees fell within plot boundaries. Each tree 5 inches d.b.h. and larger was recorded by species, diameter at breast height, and categorized into one of the following classes:

0 - green, uninfested.
1 - 1974 attack; green or partially faded foliage, brood in cambium, and blue stain present.
2 - 1973 attack; red foliage, brood emerged.
3 - 1972 or prior attack; majority of needles dropped.
4 - unsuccessful attack or pitchout, green foliage, pitchtubes present, brood and blue stain absent.

Postharvest sampling will also follow the grid, systematic method and be done:

1. During the year of harvest and after beetle flight is completed and,

2. Annually for 3 years after the beetle flight is completed.

RESULTS

Brief descriptions of each study area are given below. Habitat types were identified by Forest personnel and follow the nomenclature of Pfister et al. (1974). Analyses of preharvest sampling are also presented.

Hebgen Lake District

An infestation of mountain pine beetle developed on the Hebgen Lake District, Gallatin National Forest in 1971 (Ciesla, 1971; McGregor and Tunnock, 1971) and has continued at relatively static levels. Habitat

type within the area of infestation is *Pinus contorta/Purshia tridentata* and the stand elevation is 6,660 feet. Four study blocks were established within the boundaries of this infestation:

7-inch cut block.--This 40-acre block is located northwest of West Yellowstone, Montana (Figure 1). Harvesting of infested and all green trees above 7 inches d.b.h. was completed in 1974. Actual size of the cut area was 576 acres; however, only 40 acres were designated for purposes of this study. Average d.b.h. of trees in the stand prior to cutting was 9 inches. Phloem thickness of trees greater than 5 inches d.b.h. averaged 0.07 inch thick. Average stand age is approximately 75 years.

10-inch cut block.--A second 40-acre block was established directly south of West Yellowstone, Montana, in a lodgepole pine stand where 107 acres are scheduled for harvesting in early spring 1975 (Figure 1). Infested and all green trees 10 inches d.b.h. and greater are to be removed. Survey of the 40 acres indicated an average of 2.3 infested trees per acre. Average d.b.h. and phloem thickness of trees greater than 5 inches d.b.h. were 8.89 inches and 0.064 inch respectively. Average stand age was 193.3 years. Based on all phloem samples taken, 4.46% were greater than or equal to 0.10 inch thick.

Phloem-cut block.--A phloem cut block was established west of West Yellowstone, Montana (Figure 1). Infested and all green trees with a phloem thickness of 0.10 inch and greater are to be removed during spring 1975. Average stand age was 76.3 years. Average number of currently infested trees per acre was 2.0. Average d.b.h. and phloem thickness of trees greater than 5 inches d.b.h. were 8.69 inches and 0.0769 inch respectively. Based on phloem samples 12% of the trees had a phloem greater than or equal to 0.10 inch thick.

Check block (A).--A control block or check area was established adjacent to the 7-inch cut block northwest of West Yellowstone (Figure 1). The control block will remain undisturbed with regard to harvesting. Average number of currently infested trees per acre was 2.3. Average stand age is approximately 75 years. Average d.b.h. and phloem thickness of trees greater than 5 inches d.b.h. were 7.57 inches and 0.0744 inch respectively. Based on all phloem samples taken 13.8% had phloem thickness greater than or equal to 0.10 inch.

Gallatin District

Infestations of mountain pine beetle developed on the Gallatin District, Gallatin National Forest, in 1969 (McGregor and Dewey, 1971). Two study plots were established within the boundaries of this infestation:

12-inch cut block.--A 40-acre block designated as the 12-inch cut area was established east of the Squaw Creek Ranger Station (Figure 2). Plot elevation is 7,400 feet. Habitat type is *Pseudotsuga menziesii/Linnaea borealis*. The stand is composed of 77% lodgepole pine, 24% Douglas-fir,

FIG-1

Hebgen Lake Ranger District

Gallatin National Forest

Study Areas: 1-Check, 3-10 inch cut, 4-7inch cut, 5-phloem cut.

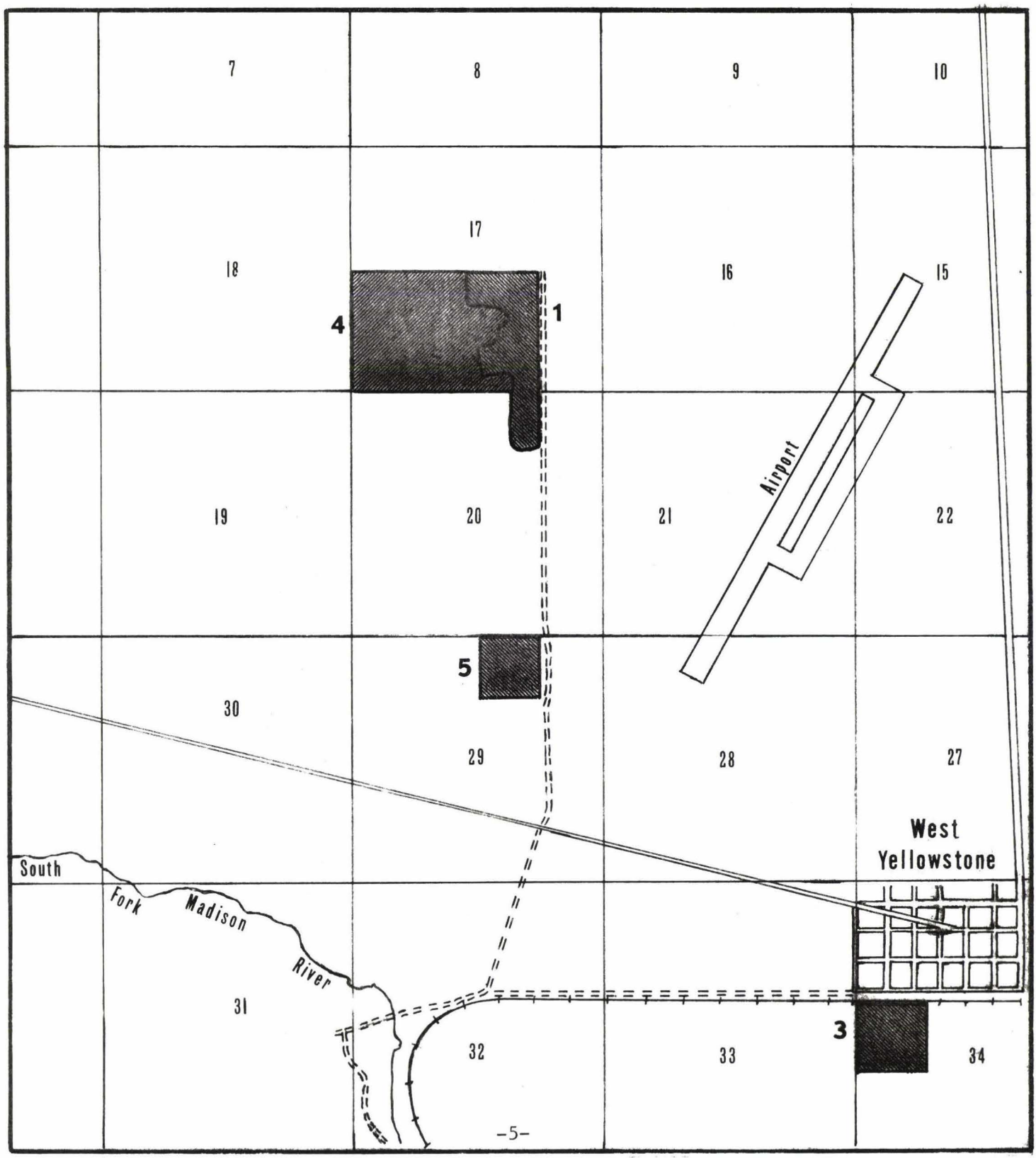
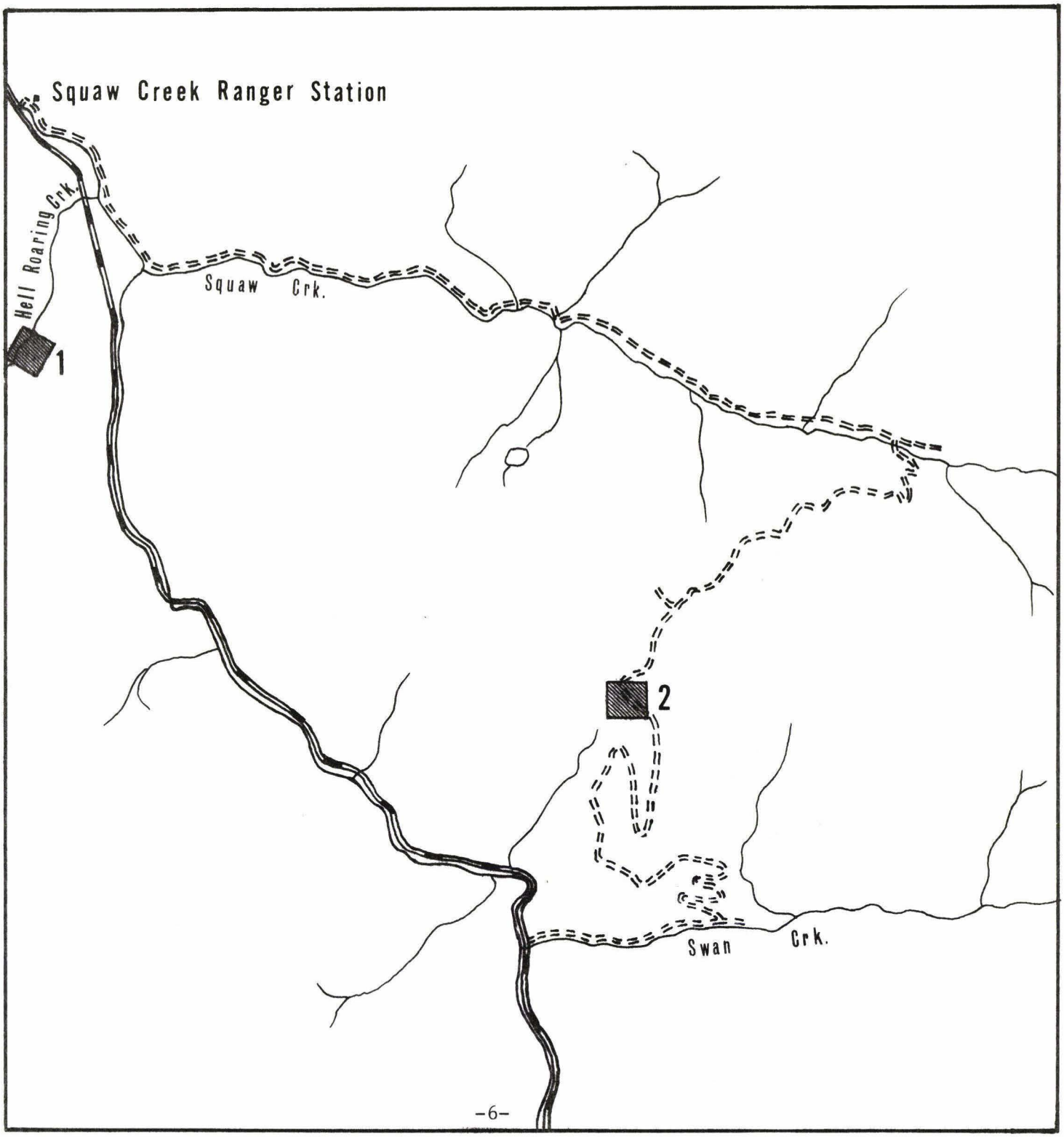


FIG-2

Gallatin Ranger District

Gallatin National Forest

Study Areas 1-Check, 2-12 inch cut



and 0.8% spruce. There was an average of 4.0 attacked trees per acre. Average stand age was 162.7 years. Average d.b.h. and phloem thickness of trees greater than 5 inches d.b.h. were 9.96 inches and 0.0782 inch respectively. Based on phloem samples taken, 17.4% were greater than or equal to 0.10 inch thick. Infested and all green trees 12 inches d.b.h. and larger will be logged from the area prior to beetle flight in 1975.

Check block (B).--Another 40-acre control block was established along Hellroaring Creek (Figure 2) at an elevation of 6,200 feet. Habitat type is *Abies lasiocarpa/Linnaea borealis*. This mixed stand is composed of 84.7% lodgepole pine, 7.2% spruce, 7.6% Douglas-fir, and 0.3% alpine fir. Average stand age is 97.5 years. Currently there are 16.0 infested trees per acre. Average d.b.h. and phloem thickness of trees greater than 5 inches d.b.h. were 7.09 inches and 0.0884 inch respectively. Based on phloem samples taken 20% were greater than 0.10 inch thick.

Relationships between d.b.h. and phloem thickness for each study area are presented in Figure 3. In all cases tree diameters and phloem thickness were strongly correlated; i.e., larger diameter trees possessed thicker phloem in each area. A summary of the preharvest sampling survey is presented in Table 1.

DISCUSSION

Since mountain pine beetle brood production has been shown to be positively correlated with phloem thickness (Amman, 1969) and phloem thickness positively correlated with tree diameter (Amman, 1972) then distributions of phloem thickness over diameter becomes an effective measurement for evaluating infestation potential in lodgepole pine stands. Based on these same measurements one should be able to implement certain harvesting strategies to eliminate or at least greatly reduce mountain pine beetle epidemic potential. For example, by selective logging those trees or diameter classes of trees which are most susceptible to attack, i.e., those 12-inch d.b.h. and greater and/or those with a phloem thickness greater than or equal to 0.10 inch, then suitable host material for beetle production could be eliminated. To field test this theory study plots have been established and given certain cutting prescriptions.

In the 7-inch cut block all trees greater than 7 inches d.b.h. were cut regardless of phloem depth. Essentially the entire range of host material was virtually eliminated since mountain pine beetle not only prefers large diameter trees but survival has been shown to be greater in them. Future infestation should be minimal in this plot. Successfully attacked trees might be suspected of being those which had thick phloem for that tree diameter.

In the 10-inch cut block, all trees greater than or equal to 10 inches d.b.h. will be cut regardless of phloem thickness. Theoretically the majority of susceptible host material will be removed, particularly the large diameter trees with thickest phloem. Average phloem thickness of

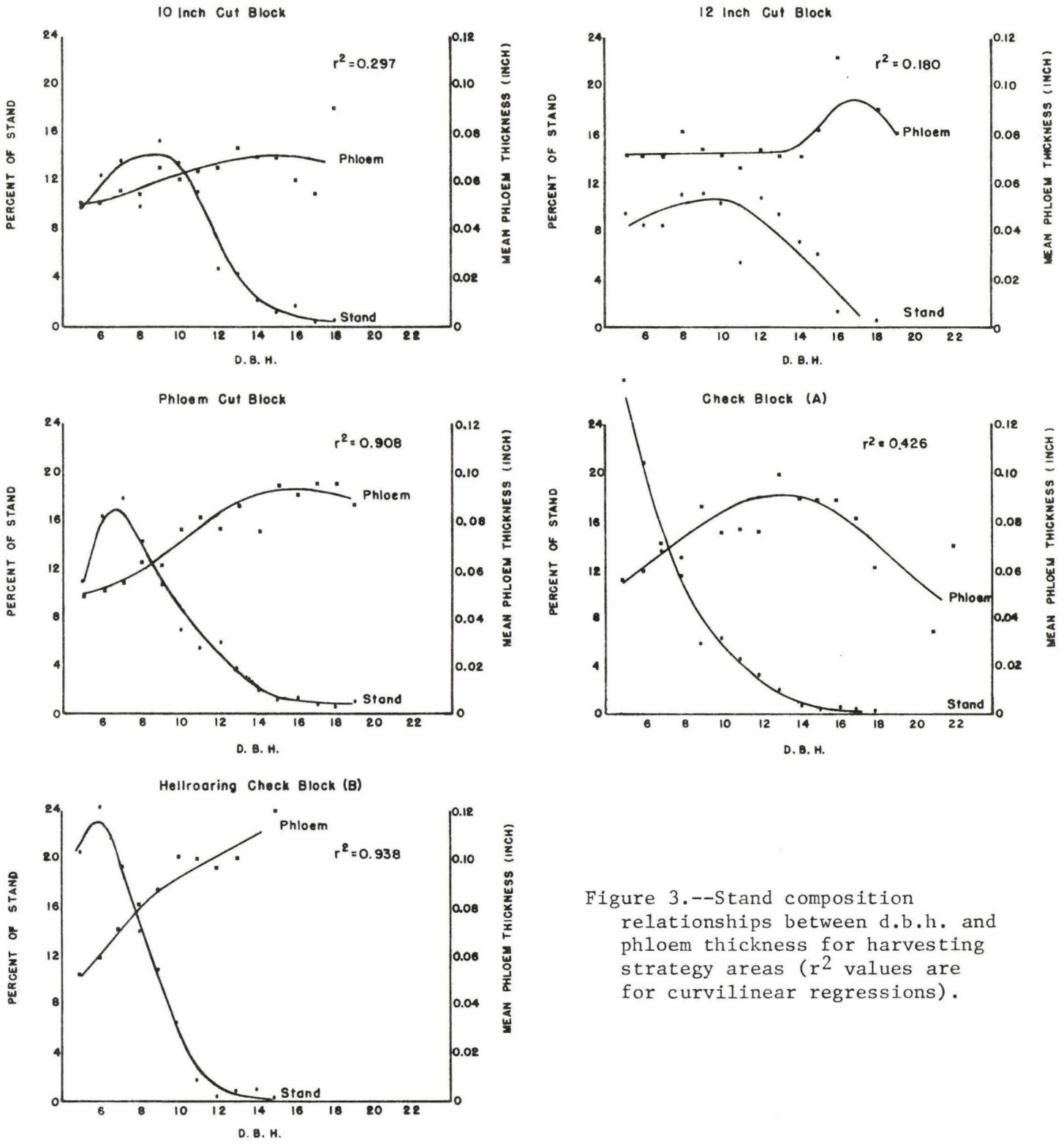


Figure 3.--Stand composition relationships between d.b.h. and phloem thickness for harvesting strategy areas (r^2 values are for curvilinear regressions).

Table 1.--Summary of preharvest sampling for mountain pine beetle study plots, Montana, 1974.

Location	Plot elevation (feet)	Average stand age (years)	Habitat type(s)	Average tree diameter (inches)	Average number infested trees/acre	% phloem samples 0.10 in. thick	Mean phloem thickness	% of stand lodgepole pine
Gallatin National Forest								
Hebgen Lake RD								
8-inch cut block	6,660	75.0	*Pinus contorta/ Purshia tridentata*	9.00	--	--	--	100.0
10-inch cut block	6,660	193.3	*Pinus contorta/ Purshia tridentata*	8.89	2.3	4.46	0.0640	100.0
Phloem cut block	6,660	76.3	*Pinus contorta/ Purshia tridentata*	8.69	2.0	12.00	.0769	100.0
Check block (A)	6,660	75.0	*Pinus contorta/ Purshia tridentata*	7.57	2.3	13.80	.0744	100.0
Gallatin RD								
12-inch cut block	7,400	162.7	*Pseudotsuga menziesii/ Linnaea borealis*	9.96	4.0	17.40	.0782	77.0
Check block (B)	6,200	97.5	*Abies lasiocarpa/ Linnaea borealis*	7.09	16.0	20.00	.0884	84.7
Kootenai National Forest								
Fisher River RD								
Observational check block	3,400-4,000	87.6	*Pseudotsuga menziesii/ Linnaea borealis* and *Abies lasiocarpa/ Clintonia uniflora*	8.44	10.4	6.00	.0715	76.9

trees in this block is 0.064 and 2.23% of the trees greater than or equal to 10 inches d.b.h. have a phloem thickness of 0.10 inch. After the selective cut is completed, the average phloem thickness of all remaining trees will be reduced to 0.057 and only 2% of the remaining stand will have a phloem thickness of 0.10 inch. Subsequently, a decrease in attack potential would be expected.

The selective harvesting plan for the 12-inch cut area is to remove all trees 12 inches d.b.h. and greater regardless of phloem thickness. Average phloem thickness of trees in this block is currently 0.078 inch, and 7.09% of the trees greater than or equal to 12 inches d.b.h. have a phloem thickness of 0.10 inch. After the selective cut is completed, average phloem thickness of remaining trees will be 0.073, and 10.4% of the remaining trees will have a phloem thickness of 0.10 inch.

In the phloem cut area all trees with a phloem thickness of greater than or equal to 0.10 inch will be removed. This will represent a low of 0 percent cut in the 5- and 6-inch diameter classes to a high of 100 percent cut in the 15-inch and larger diameter classes. Approximately 12% of all trees in the stand have a phloem thickness greater than or equal to 0.10 inch. Their removal will be expected to result in reduced mountain pine beetle buildup potential.

In each of the study areas, as a selected proportion of the large diameter trees and those with a phloem thickness greater than or equal to 0.10 inch are removed, infestation levels are expected to decline. A reduction in beetle populations should result because trees having this phloem produce fewer beetles per unit area of bark, and beetles completing development in small trees having thin phloem are usually smaller than beetles completing development in larger trees (Safranyik and Jahren, 1970), thus possibly affecting population quality.

The reduction in infestation levels in each study area is expected to be proportional to the amount of timber removed which was high risk (i.e., 12 inches d.b.h. and greater and/or with a phloem thickness greater than or equal to 0.10 inch). The three control plots, where no harvesting will occur, will provide a basis for comparison of the treatments.

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